WHAT IS CLAIMED IS:

1. An optical element comprising: an object-side imaging element for imaging an object on an intermediate image plane in an optical path; and an image-side imaging element for reimaging an object image formed on the intermediate image plane, on a final image plane, wherein at least one of said object-side imaging element and said image-side imaging element comprises an off-axial curved surface, and wherein aberration is generated by both of the object-side imaging element and the image-side imaging element, so as to flatten (disturbance of) a light intensity distribution on the final image plane, caused by a noise source at or near the intermediate image plane.

2. An optical element in which an object image is formed on an intermediate image plane by reflecting a light incident from an object through an entrance plane by at least one reflective surface of a plurality of reflective surfaces and in which a light from the object image is reflected by the remaining reflective surface or surfaces of said plurality of reflective surfaces to be made emergent from an exit plane and to be directed onto a predetermined plane, wherein at least one of an object-side imaging element ranging from the entrance plane to the intermediate image plane

and an image-side imaging element ranging from the intermediate image plane to the exit plane comprises an off-axial curved surface and wherein aberration is generated by both of said object-side imaging element and said image-side imaging element, so as to flatten a light intensity distribution produced on the predetermined plane by a noise source at or near the intermediate image plane.

3. An optical element in which an object image is formed on an intermediate image plane by reflecting a light incident from an object through an entrance surface provided in a surface of a transparent body by at least one reflective surface of a plurality of reflective surfaces provided in the surface of the transparent body and in which a light from the object image is reflected by the remaining reflective surface or surfaces of said plurality of reflective surfaces to be made emergent from an exit surface provided in the surface of the transparent body and to be directed onto a predetermined plane, wherein at least one of an object-side imaging element present from the entrance surface to the intermediate image plane and an image-side imaging element present from the intermediate image plane to the exit surface comprises an off-axial curved surface and wherein aberration is generated by both of said object-side imaging element and said

image-side imaging element, so as to flatten a light intensity distribution produced on the predetermined plane by a noise source at or near the intermediate image plane.

4. An optical element according to Claim 1, 2, or 3, wherein said aberration is generated so as to degrade imaging performance of said object-side imaging element and so as to correct the imaging performance thus degraded, by said image-side imaging element.

5. An optical element according to Claim 2 or 3, wherein said off-axial curved surface is provided in at least one reflective surface out of said plurality of reflective surfaces.

6. An optical element according to either one of Claims 1 to 5, wherein said optical element has a stop, and wherein the following relation is satisfied:

$$V/|\beta 11| < U$$

where $\beta 11$ is an image magnification of said image-side imaging element, V a spot size on the final image plane at a fixed aperture diameter of said stop, and U a spot size on said intermediate image plane.

7. An optical element according to either one of Claims 1 to 5, wherein said optical element has a stop,

and wherein the following relation is satisfied:

$$3 \cdot V/|\beta 11| < U$$

where $\beta 11$ is an image magnification of said image-side imaging element, V a spot size on the final image plane at a fixed aperture diameter of said stop, and U a spot size on said intermediate image plane.

8. An optical element according to either one of Claims 1 to 5, wherein said optical element has a stop, and wherein the following relation is satisfied:

$$5 \cdot V/|\beta 11| < U$$

where $\beta 11$ is an image magnification of said image-side imaging element, V a spot size on the final image plane at a fixed aperture diameter of said stop, and U a spot size on said intermediate image plane.

9. An optical element according to Claim 4, wherein degradation of the imaging performance of said object-side imaging element is achieved by generating specific aberration independent of a field angle from on the axis to off the axis.

10. An optical element according to Claim 9, wherein said specific aberration is on-axis astigmatism.

11. An optical element according to Claim 9,

wherein degradation of the imaging performance of said object-side imaging element is achieved by such aberration of torsion that rays in a meridional section jump out of the meridional section, which is generated independent of the field angle from on the axis to off the axis.

12. An optical element according to Claim 9 or 11, wherein a diameter of a spot near said intermediate image plane is two or more times a minimum diameter of said noise source posing a problem even when the system is at a minimum aperture value.

13. An optical element according to Claim 9 or 11, wherein a diameter of a spot near said intermediate image plane is three or more times a minimum diameter of said noise source posing a problem even when the system is at a minimum aperture value.

14. An optical element according to Claim 9 or 11, wherein a diameter of a spot near said intermediate image plane is three or more times a minimum diameter of said noise source posing a problem when the system is at a full aperture.

15. An optical element according to Claim 9 or 11, wherein a diameter of a spot near said intermediate

image plane is five or more times a minimum diameter of said noise source posing a problem when the system is at a full aperture.

16. An optical element according to either one of Claims 1 to 15, said optical element being constructed in a structure in which a focal length thereof is invariant.

17. An optical element according to either one of Claims 1 to 16, wherein at least one of said object-side imaging element and image-side image element has a surface having anamorphic powers.

18. An optical element according to either one of Claims 1 to 17, wherein at least one of said object-side imaging element and image-side imaging element is comprised of an optical system having no common symmetry plane.

19. An optical element according to either one of Claims 1 to 17, wherein at least one of said object-side imaging element and image-side imaging element comprises a surface with no symmetry at all.

20. An optical apparatus wherein said object is imaged on a photoreceptive surface of an image pickup

device by use of the optical element as set forth in either one of Claims 1 to 19.

21. An optical apparatus comprising at least two optical elements as set forth in either one of Claims 1 to 19, wherein relative positions are changed between said at least two optical elements, whereby the object is imaged at different magnifications on an image pickup device.

22. An optical apparatus according to Claim 20 or 21, wherein a stop is provided near the entrance surface of said optical element and wherein the following relation is satisfied:

$10 \cdot b / |\beta 11| < SD$

where SD is a spot diameter on said intermediate image plane, b a length of a minimum resolution given by a size of a pixel of said image pickup device when said stop is at a minimum aperture value, and β11 an image magnification of said image-side imaging element.

23. An optical apparatus according to Claim 20 or 21, wherein a stop is provided near the entrance surface of said optical element and wherein the following relation is satisfied:

$15 \cdot b / |\beta 11| < SD$

where SD is a spot diameter on said intermediate image

plane, b a length of a minimum resolution given by a size of a pixel of said image pickup device when said stop is at a minimum aperture value, and β11 an image magnification of said image-side imaging element.

24. An optical apparatus according to Claim 20 or 21, wherein a stop is provided near the entrance surface of said optical element and wherein the following relation is satisfied:

$$15 \cdot b/|\beta 11| < SD$$

where SD is a spot diameter on said intermediate image plane, b a length of a minimum resolution given by a size of a pixel of said image pickup device when said stop is at a full aperture value, and β11 an image magnification of said image-side imaging element.

25. An optical apparatus according to Claim 20 or 21, wherein a stop is provided near the entrance surface of said optical element and wherein the following relation is satisfied:

$$25 \cdot b/|\beta 11| < SD$$

where SD is a spot diameter on said intermediate image plane, b a length of a minimum resolution given by a size of a pixel of said image pickup device when said stop is at a full aperture value, and β11 an image magnification of said image-side imaging element.

26. An optical apparatus according to Claim 21, wherein change of the relative positions between said at least two optical elements is achieved by displacing at least one of said optical elements in a direction of a reference axis.

27. An optical system comprising: an object-side imaging element for once imaging an object on an intermediate image plane in an optical path; and an image-side imaging element for reimaging an object image formed on the intermediate image plane, on a final image plane, wherein at least one of said object-side imaging element and said image-side imaging element comprises an off-axial curved surface, and wherein aberration is generated by both of the object-side imaging element and the image-side imaging element, so as to flatten of a light intensity distribution on the final image plane, caused by a noise source at or near the intermediate image plane.

28. An optical system according to Claim 27, wherein said off-axial curved surface is comprised of a reflective surface.

29. An optical system according to Claim 27 or 28, wherein said aberration is generated so as to degrade imaging performance of said object-side imaging

element and so as to correct the imaging performance thus degraded, by said image-side imaging element.

30. An optical system according to either one of Claims 27 to 29, wherein said optical system has a stop, and wherein the following relation is satisfied:

$$V/|\beta 11| < U$$

where $\beta 11$ is an image magnification of said image-side imaging element, V a spot size on the final image plane at a fixed aperture diameter of said stop, and U a spot size on said intermediate image plane.

31. An optical system according to either one of Claims 27 to 29, wherein said optical system has a stop, and wherein the following relation is satisfied:

$$3 \cdot V/|\beta 11| < U$$

where $\beta 11$ is an image magnification of said image-side imaging element, V a spot size on the final image plane at a fixed aperture diameter of said stop, and U a spot size on said intermediate image plane.

32. An optical system according to either one of Claims 27 to 29, wherein said optical system has a stop, and wherein the following relation is satisfied:

$$5 \cdot V/|\beta 11| < U$$

where $\beta 11$ is an image magnification of said image-side imaging element, V a spot size on the final image plane

at a fixed aperture diameter of said stop, and U a spot size on said intermediate image plane.

33. An optical system according to Claim 29, wherein degradation of the imaging performance of said object-side imaging element is achieved by generating specific aberration independent of a field angle from on the axis to off the axis.

34. An optical system according to Claim 33, wherein said specific aberration is on-axis astigmatism.

35. An optical system according to Claim 33, wherein degradation of the imaging performance of said object-side imaging element is achieved by such aberration of torsion that rays in a meridional section jump out of the meridional section, which is generated independent of the field angle from on the axis to off the axis.

36. An optical system according to Claim 33 or 35, wherein a diameter of a spot near said intermediate image plane is two or more times a minimum diameter of said noise source posing a problem even when the system is at a minimum aperture value.

37. An optical system according to Claim 33 or 35, wherein a diameter of a spot near said intermediate image plane is three or more times a minimum diameter of said noise source posing a problem even when the system is at a minimum aperture value.

38. An optical system according to Claim 33 or 35, wherein a diameter of a spot near said intermediate image plane is three or more times a minimum diameter of said noise source posing a problem when the system is at a full aperture.

39. An optical system according to Claim 33 or 35, wherein a diameter of a spot near said intermediate image plane is five or more times a minimum diameter of said noise source posing a problem when the system is at a full aperture.

40. An optical system according to either one of Claims 27 to 39, said optical system being a unifocal system in which a focal length thereof is invariant.

41. An optical system according to either one of Claims 27 to 40, wherein at least one of said object-side imaging element and image-side imaging element has a surface having anamorphic powers.

42. An optical system according to either one of Claims 27 to 41, wherein at least one of said object-side imaging element and image-side imaging element is comprised of an optical system having no common symmetry plane.

43. An optical system according to either one of Claims 27 to 41, wherein at least one of said object-side imaging element and image-side imaging element comprises a surface with no symmetry at all.

44. An optical apparatus wherein said object is imaged on a photoreceptive surface of an image pickup device by use of the optical system as set forth in either one of Claims 27 to 43.

45. An optical apparatus comprising at least one optical system selected from those as set forth in Claims 27 to 44, wherein at least one of a focal length, an image magnification, and a focus on the final image plane is variable.

46. An optical apparatus according to Claim 44 or 45, wherein a stop is provided near the entrance surface of said optical system and wherein the following relation is satisfied:

$$10 \cdot b / |\beta 11| < SD$$

where SD is a spot diameter on said intermediate image plane, b a length of a minimum resolution given by a size of a pixel of said image pickup device when said stop is at a minimum aperture value, and $\beta 11$ an image magnification of said image-side imaging element.

47. An optical apparatus according to Claim 44 or 45, wherein a stop is provided near the entrance surface of said optical system and wherein the following relation is satisfied:

$$15 \cdot b/|\beta 11| < SD$$

where SD is a spot diameter on said intermediate image plane, b a length of a minimum resolution given by a size of a pixel of said image pickup device when said stop is at a minimum aperture value, and $\beta 11$ an image magnification of said image-side imaging element.

48. An optical apparatus according to Claim 44 or 45, wherein a stop is provided near the entrance surface of said optical system and wherein the following relation is satisfied:

$$15 \cdot b/|\beta 11| < SD$$

where SD is a spot diameter on said intermediate image plane, b a length of a minimum resolution given by a size of a pixel of said image pickup device when said stop is at a full aperture value, and $\beta 11$ an image magnification of said image-side imaging element.

49. An optical apparatus according to Claim 44 or 45, wherein a stop is provided near the entrance surface of said optical system and wherein the following relation is satisfied:

$$25 \cdot b/|\beta 11| < SD$$

where SD is a spot diameter on said intermediate image plane, b a length of a minimum resolution given by a size of a pixel of said image pickup device when said stop is at a full aperture value, and β11 an image magnification of said image-side imaging element.

50. An optical apparatus according to Claim 45, wherein change of relative positions between said at least two optical systems or between the optical system and the image plane is achieved by displacing at least one of said optical system and the image plane in a direction of a reference axis.

51. An optical apparatus according to Claim 45, wherein change of at least one of said focal length, image magnification, and focus on the final image plane, of said optical system, is achieved by changing a distance of a certain portion of the optical system relative to the final image plane along a reference axis.

52. An optical system according to Claim 33 or

34, said optical system being a reflecting optical system wherein the light from the object is made incident through an entrance surface formed in a surface of a transparent body thereinto, light propagating inside said transparent body is reflected by one or more reflective surfaces comprised of curved surfaces provided in said transparent body, and the light is made emergent from an exit surface of the transparent body to form an image, or a reflecting optical system wherein the light from the object is reflected by a plurality of reflective surfaces comprised of reflective mirrors and thereafter the light is emergent therefrom.

53. An optical system according to Claim 52, said optical system being an optical element integrally formed.

54. An optical system according to Claim 52, said optical system comprising a plurality of optical elements integrally formed.

55. An optical system according to either one of Claims 52 to 54, wherein the following condition is satisfied:

$$\left|\frac{D \cdot f1}{S \cdot AR1}\right| < 0.1$$

where D is a size of a bubble, a dust particle, or the like posing a problem in terms of optical performance and existing inside said optical element or a width of a flaw or a size of a deposit or the like posing a problem in terms of optical performance and existing on a reflective surface near the intermediate image position, f1 is a maximum synthetic focal length out of those dependent upon azimuths, of a region from the entrance surface located nearest to the object to an optical surface before the intermediate image position, an azimuth at that time being defined as ξ, S is an on-axis astigmatic difference at the intermediate image position, and AR1 is a diameter of an exit pupil from the entrance surface nearest to the object to the optical surface before said intermediate image position in correspondence to said azimuth ξ and at a full aperture of the stop.

56. An optical system according to either one of Claims 52 to 54, said optical system having a function to adjust an aperture diameter of the stop, wherein the following condition is satisfied:

$$\left|\frac{D\cdot f1}{S\cdot AR2}\right|<0.3$$

where D is a size of a bubble, a dust particle, or the like posing a problem in terms of optical performance and existing inside said optical element or a width of

a flaw or a size of a deposit or the like posing a problem in terms of optical performance and existing on a reflective surface near the intermediate image position, f1 is a maximum synthetic focal length out of those dependent upon azimuths, of a region from the entrance surface located nearest to the object to an optical surface before the intermediate image position, an azimuth at that time being defined as ξ, S is an on-axis astigmatic difference at the intermediate image position, and AR2 is a diameter of an exit pupil from the entrance surface nearest to the object to the optical surface before said intermediate image position in correspondence to said azimuth ξ and at a small aperture of the stop.

57. An optical system according to either one of Claims 52 to 54, wherein the following condition is satisfied:

$$\left|\frac{5b\cdot f1}{|\beta|\cdot S\cdot AR1}\right|<0.1$$

where f1 is a maximum synthetic focal length out of those dependent on azimuths, of a region from the entrance surface of said optical system nearest to the object to an optical surface before the intermediate image position, an azimuth at that time being defined as ξ, S is an on-axis astigmatic difference at the intermediate image position, b is a length of a minimum

resolution given by a size of a pixel of an image pickup device or the like, β is an image magnification when the intermediate image plane is imaged on the final image plane, in a direction normal to the azimuth ξ in the optical system of from the intermediate image position to the final image position on which the image pickup device is located, and AR1 is a diameter of an exit pupil of the region from the entrance surface nearest to the object to the optical surface before the intermediate image position in correspondence to said azimuth ξ and at a full aperture of the stop.

58. An optical system according to either one of Claims 52 to 54, said optical system having a function to adjust an aperture diameter, wherein the following condition is satisfied:

$$\left|\frac{5b\cdot f1}{|\beta|\cdot S\cdot AR2}\right|<0.3$$

where f1 is a maximum synthetic focal length out of those dependent on azimuths, of a region from the entrance surface of said optical system nearest to the object to an optical surface before the intermediate imaging position, an azimuth at that time being defined as ξ, S is an on-axis astigmatic difference at the intermediate image position, b is a length of a minimum resolution given by a size of a pixel of an image pickup device or the like, β is an image magnification

when the intermediate image plane is imaged on the final image plane, in a direction normal to the azimuth ξ in the optical system of from the intermediate image position to the final image position on which the image pickup device is located, and AR2 is a diameter of an exit pupil of the region from the entrance surface nearest to the object to the optical surface before the intermediate image position in correspondence to said azimuth ξ and at a small aperture of the stop.

59. An optical system according to either one of Claims 52 to 58, wherein the entrance surface of the optical element being said transparent body is a rotationally symmetric surface.

60. An optical system according to either one of Claims 52 to 58, wherein the entrance surface of the optical element being said transparent body is a rotationally asymmetric surface.

61. An optical system according to either one of Claims 52 to 60, wherein the stop is disposed near the entrance surface nearest to the object in said optical system.

62. An optical system according to either one of Claims 52 to 61, wherein the reflective surface of a

curved surface, which is the first surface when counted from the object side of said optical system, has converging action.

63. An optical system according to either one of Claims 52 to 62, wherein the exit surface of the optical element being said transparent body has a rotationally symmetric shape with respect to a reference axis.

64. An optical system according to either one of Claims 52 to 62, wherein the exit surface of the optical element being said transparent body has a rotationally asymmetric shape with respect to a reference axis.

65. A reflecting optical system according to either one Claims 52 to 64, wherein said optical element is arranged to move in parallel to a direction of a reference axis emerging therefrom, thereby achieving focusing.

66. An optical system according to either one of Claims 54 to 65, said optical system being a reflection type zoom optical system wherein the object is imaged through a plurality of optical elements and zooming is achieved by changing relative positions of at least two

optical elements out of said plurality of optical elements.

67. An image pickup apparatus having the optical system as set forth in either one of Claims 52 to 66, wherein said object is imaged on an image pickup surface.

68. An observation optical system having the optical system as set forth in either one of Claims 52 to 66.